AMAS ROBOTICS SEMINAR BRIEF

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Robotic Systems Joint Project Office

ROBOTIC SYSTEMS JPO

MISSION

Lead the development, systems engineering, integration, acquisition, testing, fielding, sustainment and improvement of unmanned systems for the Joint Warfighter to ensure safe, effective and supportable capabilities are provided while meeting cost, schedule and performance.

VISION

Continuous improvement of unmanned system capabilities to meet current and future Joint Warfighter objectives.

Leadership • Service • Innovation
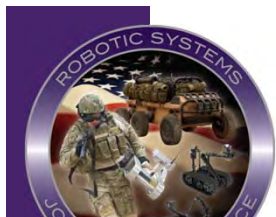
TARDEC – Who We Are

Combat Vehicles

Heavy Tactical Vehicle

Medium Tactical Vehicle

Light Tactical Vehicle

Countermine Equipment

Military Bridging

Trailers

Fuel and Water Storage & Distribution Quality Surveillance Equipment

Logistics Equipment

Watercraft

Water Generation and Purification

MISSION: Provide full service life cycle engineering support to our TACOM LCMC customers (PEO GCS, PEO CS&CSS, ILSC) and PM FCS (BCT), to develop and integrate the right technology solutions to improve the effectiveness of the current force and realize the superior capability of the future force to facilitate army transformation.
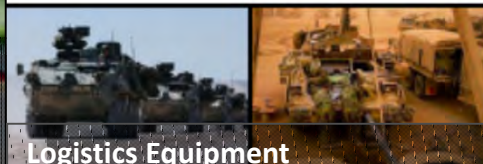
VISION: Be the first choice of technology and engineering expertise for ground vehicle systems and support equipment - today and tomorrow.
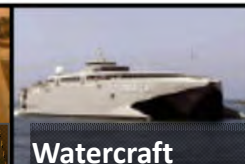
TARDEC is responsible for research, development and engineering support to more than **2,800** Army systems and many of the Army's and DoD's top joint warfighter development programs.

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AMAS Operation modes and Outcomes

AMAS Operation modes:

- Driver Assist
- Tele-operation
- Supervised autonomy
- Leader/follower
- Waypoint navigation
- Go to point/Dynamic Re-routing

Operational Outcomes:

- Sustained unmanned or driver assisted Warfighter Functions.
- Improvements in Unmanned or Robot assisted vehicles allows Soldiers to Neutralize road-side threats, e.g. IEDs quicker, allowing them additional reaction time.
- Unmanned reconnaissance and surveillance.
- Commander's ability to reduce Soldier risk.

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AMAS JCTD – Technical Overview

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- Provide scalable autonomy in a single material solution agnostic of platform
  - ➢ Autonomy Kit
    - » Autonomous Hardware and Sensors
  - ➢ By-wire Kit
    - » Vehicle Specific Devices to Retrofit Current Tactical Vehicles
  - ➢ Common Interfaces
  - ➢ Common Framework

- Scalable and flexible to address multiple task such as convoys, security, reconnaissance, sustainment, maneuver, maneuver support

- Operational scenario using a secure mixed manned/unmanned platform convoy
  - ➢ Year One Platforms - MTVR, LTV, HEMTT, M915 w/trailer
  - ➢ Year Two Platforms - PLS, HMMWV, MATV, FMTV w/trailer
  - ➢ Demonstrate increased vehicle safety with high op tempo in complex conditions

- Conduct Technical Demos and Operational Demo (CONUS): Manned, Driver Assist, Remote Control, and Semi- Autonomous Leader/Follower.

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AMAS JCTD – Key Metrics

Capability	Tasks	Metric	Threshold	Objective
FOC 09-08 Soldier Support	Operator Interventions	Hours	TBD	TBD
Joint Land Ops	System Operation Range	Distance in meters	TBD	TBD
FOC 09-04 Operational Tempo	Speed	Kph	Max>40kph Min <5kph	Max>80kph Min<1kph
Joint Land Ops	Lateral Accuracy	Centimeters from lead path	100cm	50cm
Battle space Awareness	Obstacle Avoidance	Size in cm^3	TBD	TBD
FOC 07-01 Protect personnel	Situational Awareness	Sighting increase %	Target sighting increase 10%	Target sighting increase 20%
FOC 07-01 Protect personnel	Emergency braking	Operator Interventions per hour	1	0
Tactical behaviors	Multi-vehicle capability	Vehicles	4	20
Collaborative Operations	Leader / follower swap	Transition time in seconds	Less than 30 seconds	Less than 10 seconds
FOC 09-04 Operational Tempo	Controlling Platform	Distance from Operator	LOS 2 km	NLOS 1 km

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JCTD Transition Strategy

AMAS JCTD

Year One
- Contract Award
- 1st Tech Demo
- ATEC Reports

Year Two
- 2nd Tech Demo
- Operation Utility Assessment (OUA)
- ATEC Reports

Risk Reducers:
- Push AMAS Program Schedule to the Left
- Accelerate Technical Maturation
- Provide Open Architecture and Interfaces
- Standardized Metrics and Test Procedures
- Framework for Validation of Requirements
- Lessons Learned

AMAS CDD/CPD

Year One
- CDD Staffing

Year One
- AROC/JROC Approval
- POM Line Establishment
- MDD Preparation

Year Two
- » MDD
- » AOA Study Guidance
- » Solicitation Preparation and Acquisition Strategy for CDD

  OR
- » Development of CPD

Year Three (Transition Year)
- Milestone B
- EMD Contract Award(s)

  OR
- CPD AROC/JROC Approval

The AMAS JCTD will provide Risk Reduction to the AMAS Program

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AMAS – Capabilities of Scalable Autonomy

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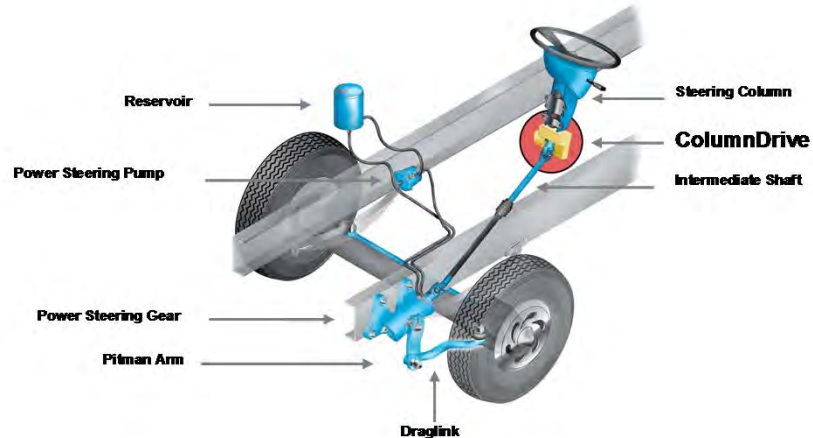| Level 1 Driver Assist	Level 2 Automated Driving	Level 3 Convoy Behaviors

• **Increase Situational Awareness**
 	
  • Environment and Surroundings
 	
  • Vehicle Capabilities and Configuration
 	
• **Improved Safety**
 	
  • Collision Warnings
 	
  • Lane Departure Warnings
 	
  • Tip Over Warnings
 	
  • Stability Control
 	
• **Reinforces Experienced drivers**
 	
• **Increase Capabilities of inexperienced Drivers**
	• **Active Intervention**
	
	  • Maintain Lane Control
	
	  • Tip-Over Prevention
	
	  • Collision avoidance and mitigation
	
	  • Stability Control
	
	• **Enables operator to focus on other convoy mission tasks while the vehicle safely operates itself.**
		• **Leader/Follower Capabilities**
		
		  • Increase Operational Tempo
		
		  • Run faster with disciplined spacing
		
		  • Increased convoy capacity though unmanned vehicles
		
		• **Increase throughput and efficiencies**
		
		• **Dynamic planning and re-planning**
		
		  • Flexibility in convoy composition and routing
		
		  • Re-acquire route after dispersal
		
		  • Re-plan route to alternate

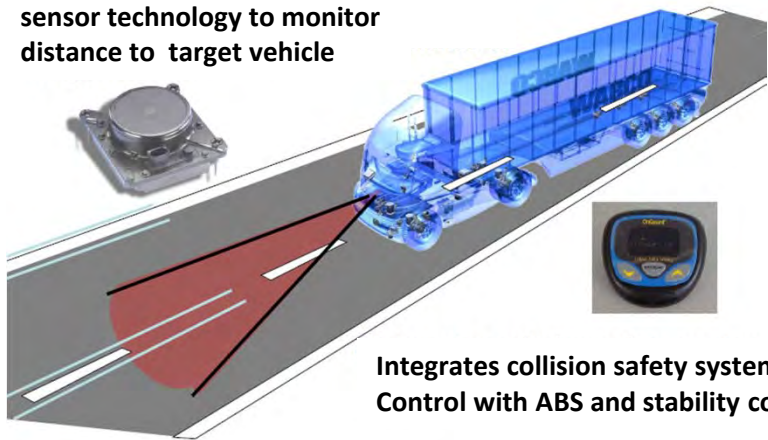Leadership • Service • Innovation

Level 1 Technology: Driver Assist

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Technologies	Outcomes	Achieved Capabilities

Drive By Wire
•TRL 9, mature technology
•Augmentation (mostly)
•< $5K per vehicle (avg; platform dependent)
•< 100 lbs (avg; platform dependent)
Vehicle State Information
•TRL 9, mature technology
•Augmentation
•< $500
• Minimal impact on weight and cube
External Situation Awareness (sensors)
•TRL 9, mature technology
•Augmentation
•< $5K per vehicle
•< 10 lbs per vehicle (avg; platform dependent)
Software
•TRL 6, Integrating the separate pieces
•Augmentation
•Cost in development
•No weight/cube impact
	• **Increase Situational Awareness**
	  • Environment and Surroundings
	  • Vehicle Capabilities and Configuration
	• **Improved Safety**
	  • Collision Warnings
	  • Lane Departure Warnings
	  • Tip Over Warnings
	  • Stability Control
	• **Reinforces Experienced drivers**
	• **Increase Capabilities of inexperienced Drivers**
		• Level 1 technologies enable higher levels required to meet the AMAS CDD Operational modes

Level 1 Technology Examples

Reservoir

Power Steering Pump

Steering Column

ColumnDrive

Intermediate Shaft

Power Steering Gear

Pitman Arm

Draglink

Uses forward looking radar sensor technology to monitor distance to target vehicle

Integrates collision safety system Control with ABS and stability control

Vehicle Control Systems

SmartTrac

Automatic Traction Control (ATC)

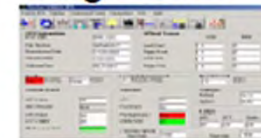**Hill Holder and Work Brake**

Driveline Protection Management

ABS

OnGuard

SafetyDirect™
Fleet Performance System

Brake Performance Monitoring (BPM)

Diagnostics

Tire Pressure Monitoring (TPM)

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Level 2 Technology: Automated Driver

ROBOTIC SYSTEMS JPO

Technologies	Outcomes	Capabilities Achieved

Advanced Sensors
•TRL 9, mature technology
•Augmentation
•< $10K per vehicle
•< 10 lbs (no major impact to vehicle)
 	
Software
•TRL 6, Integrating the separate pieces
•Augmentation
•Cost in development
    Significantly greater than Level 1
    Software Cost
•No weight/cube impact
	• **Active Intervention**
	  • Maintain Lane Control
	  • Tip-Over Prevention
	  • Collision avoidance and mitigation
	  • Stability Control
	• **Enables operator to focus on other convoy mission tasks while the vehicle safely operates itself.**
		•Driver Assist
		•Supervised autonomy
		•Leader/follower
		•Waypoint navigation
		•Go to point/Dynamic Re-routing

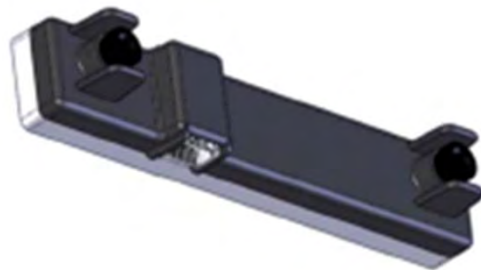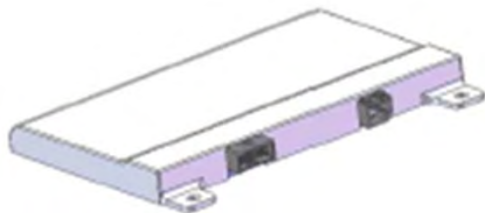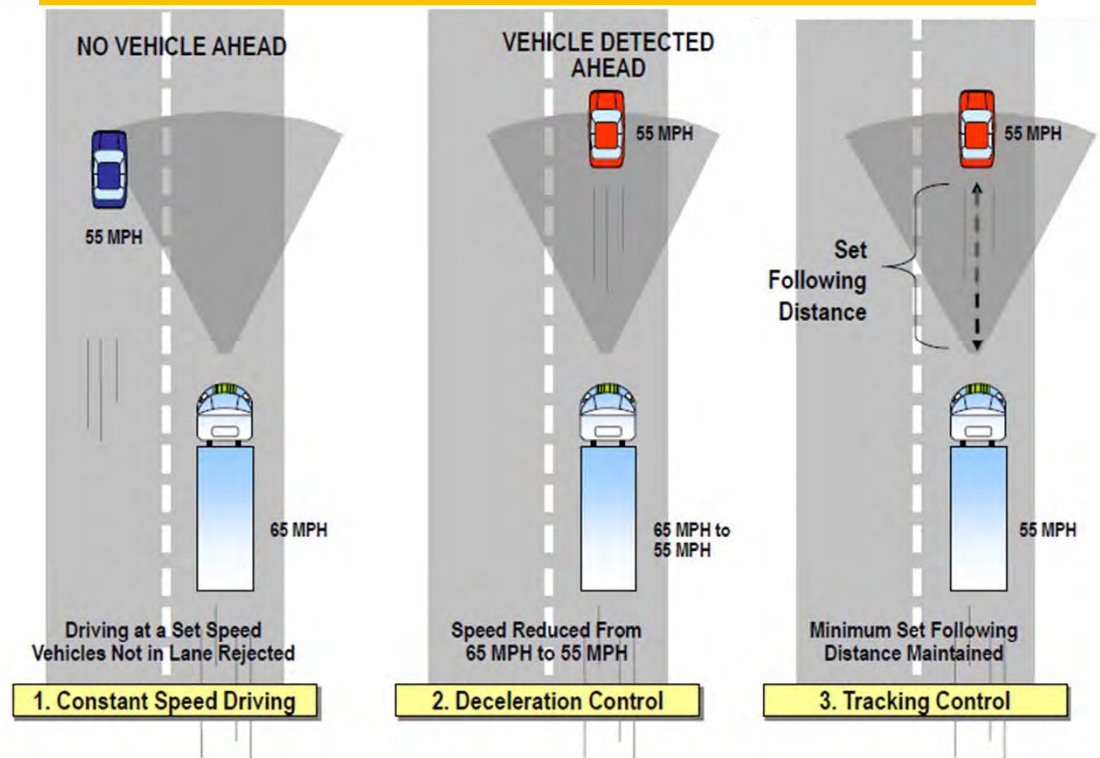**Leadership • Service • Innovation**

Level 2 Technology Examples

Image Sensor Module

Driver Assistance Safety Mod

Automatic Cruise Control - Functionality



NO VEHICLE AHEAD

55 MPH

65 MPH

Driving at a Set Speed
Vehicles Not in Lane Rejected

1. Constant Speed Driving

VEHICLE DETECTED AHEAD

55 MPH

65 MPH to
55 MPH

Speed Reduced From
65 MPH to 55 MPH

2. Deceleration Control

55 MPH

Set Following Distance

55 MPH

Minimum Set Following
Distance Maintained

3. Tracking Control

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Level 3 Technology: Convoy Behaviors

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Technologies	Outcomes	Achieved Capabilities

No Tele-operation, vehicle to vehicle communications
•TRL 9, mature technology
•Augmentation
•< $10K per vehicle
•< 50 lbs
 	
Network, Command and Control (C^2)
•TRL 9, mature technology
•Augmentation
•< $20K per convoy (may already be on C^2 vehicles)
• < 50 lbs
 	
Advanced Software
•TRL 6
•Augmentation
•Cost in development
•Significantly greater than Level 2 Software Cost
•No weight/cube impact
 	
Control/Monitor hardware above unit
•TRL 6, Integrating the separate pieces
•Augmentation
•~ $100K per vehicle based control station, <$5K per monitoring station
•< 400 lbs
	• **Leader/Follower Capabilities**
	
	  • Increase Operational Tempo
	
	  • Run faster with disciplined spacing
	
	  • Increased convoy capacity though unmanned vehicles
	
	• **Increase throughput and efficiencies**
	
	• **Dynamic planning and re-planning**
	
	  • Flexibility in convoy composition and routing
	
	  • Re-acquire route after dispersal
	
	  • Re-plan route to alternate
		•Driver Assist
		•Tele-operation
		•Supervised autonomy
		•Leader/follower
		•Waypoint navigation
		•Go to point/Dynamic Re-routing

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Level 3 Technology Examples
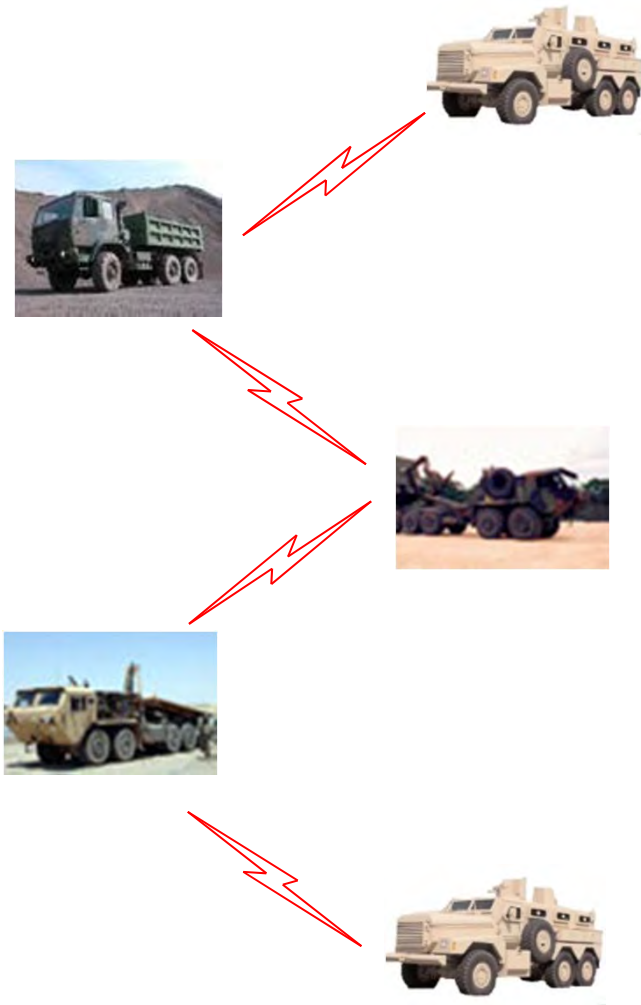
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Questions?

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